



(11)

EP 2 599 487 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

01.04.2015 Bulletin 2015/14

(21) Application number: **11812616.8**

(22) Date of filing: **29.07.2011**

(51) Int Cl.:

A61K 31/415 ^(2006.01) **A61K 31/195** ^(2006.01)
A61K 31/422 ^(2006.01) **A61K 31/427** ^(2006.01)
A61K 31/4439 ^(2006.01) **A61K 45/06** ^(2006.01)
A61P 25/04 ^(2006.01) **A61P 43/00** ^(2006.01)

(86) International application number:

PCT/JP2011/067431

(87) International publication number:

WO 2012/015027 (02.02.2012 Gazette 2012/05)

(54) **THERAPEUTIC AGENT OR PROPHYLACTIC AGENT FOR NEUROPATHIC PAIN**

THERAPEUTIKUM ODER PROPHYLAKTIKUM FÜR NEUROPATHISCHE SCHMERZEN

AGENT THÉRAPEUTIQUE OU PROPHYLACTIQUE POUR DOULEUR NEUROPATHIQUE

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(30) Priority: **30.07.2010 JP 2010171384**

(43) Date of publication of application:

05.06.2013 Bulletin 2013/23

(73) Proprietor: **Toray Industries, Inc.**

Tokyo, 103-8666 (JP)

(72) Inventors:

• **IZUMIMOTO, Naoki**
Kamakura-shi
Kanagawa 248-8555 (JP)

• **MOCHIZUKI, Hidenori**
Kamakura-shi
Kanagawa 248-8555 (JP)

(74) Representative: **Kador & Partner**

Corneliusstraße 15
80469 München (DE)

(56) References cited:

WO-A1-2004/016259 WO-A1-2010/050577
WO-A1-2011/125836 JP-A- 11 193 281
JP-A- 2005 060 311

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a therapeutic agent or a prophylactic agent for neuropathic pain.

BACKGROUND ART

10 **[0002]** Neuropathic pain (also referred to as neurogenic pain) means a pain which is caused by a disorder or a disease in the peripheral or central somatosensory nervous system and which results from a direct injury, compression or the like to nerve tissue without any noxious stimuli to a nociceptor.

15 **[0003]** As a therapeutic drug for neuropathic pain, anticonvulsants, antidepressants and antianxiety agents, as well as antiepileptics including pregabalin and gabapentin, which are calcium channel $\alpha 2\delta$ ligands, have been used (Non-patent Document 1). Among these, pregabalin is a world standard therapeutic drug for neuropathic pain, but it has been known that administration of pregabalin frequently causes side effects such as dizziness, somnolence, ataxia, weakness and the like, which are thought to be based on the inhibitory effects on the central nervous system (Non-patent Document 2).

20 **[0004]** In order to reduce the dose of pregabalin or gabapentin, combined use of these calcium channel $\alpha 2\delta$ ligands with various drugs has been studied in recent years, and it has been reported that a synergistic analgesic effect can be obtained by combined use of, for example, a calcium channel $\alpha 2\delta$ ligand with a phosphodiesterase type 5 inhibitor sildenafil, tadalafil or vardenafil (Patent Document 1) or with other drugs (Patent Documents 2 to 10 and Non-patent Documents 8 to 12), or by combined use of gabapentin with a nonopioid analgesic acetaminophen (Non-patent Document 3) or nitro-paracetamol (Non-patent Document 4), or with an opioid analgesic oxycodone (Non-patent Document 5) or morphine (Non-patent Document 13), or with a vitamin B1 derivative benfotiamine (Non-patent Document 6) or vitamin B12 cyanocobalamin (Non-patent Document 6). Furthermore, it has been also reported that a synergistic analgesic effect can be obtained by combined use of 3 drugs, gabapentin, donepezil (cholinesterase inhibitor) and duloxetine (serotonin and noradrenaline reuptake inhibitor) (Non-patent Document 7).

PRIOR ART DOCUMENTS

30

PATENT DOCUMENTS

[0005]

35 Patent Document 1: WO 04/016259
 Patent Document 2: WO 10/025931
 Patent Document 3: WO 09/021058
 Patent Document 4: WO 08/079727
 Patent Document 5: WO 08/079720
 40 Patent Document 6: WO 07/090661
 Patent Document 7: WO 05/102390
 Patent Document 8: WO 05/025675
 Patent Document 9: WO 01/024792
 Patent Document 10: WO 01/013904
 45 Patent Document 11: WO 10/050577

NON-PATENT DOCUMENTS

[0006]

50

Non-patent Document 1: Dooley et al., Trends Pharmacol Sci, 2007, Vol. 28, p. 75
 Non-patent Document 2: Zaccara et al., Seizure, 2008, Vol. 17, p. 405
 Non-patent Document 3: Hama et al., Neuropharmacology, 2010, Vol. 58, p. 758
 Non-patent Document 4: Curros-Criado et al., Br J Pharmacol, 2009, Vol. 158, p. 601
 55 Non-patent Document 5: Hanna et al., Eur J Pain, 2008, Vol. 12, p. 804
 Non-patent Document 6: Mixcoatl-Zecuatl et al., Methods Find Exp Clin Pharmacol, 2008, Vol. 30, p. 431
 Non-patent Document 7: Hayashida et al., Eur J Pharmacol, 2008, Vol. 598, p. 21
 Non-patent Document 8: Tomic et al., Eur J Pharmacol, 2010, Vol. 628, p. 75

Non-patent Document 9: Park et al., J Korean Med Sci, 2008, Vol. 23, p. 678

Non-patent Document 10: Imai et al., Eur J Pharmacol, 2008, Vol. 588, p. 244

Non-patent Document 11: Codd et al., Pain, 2008, Vol. 134, p. 254

Non-patent Document 12: Hayashida et al., Anesthesiology, 2007, Vol. 106, p. 1213

Non-patent Document 13: De la O-Arciniega et al., Pharmacol Biochem Behav, 2009, Vol. 92, p. 457

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

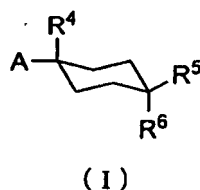
[0007] However, in the combination therapy with a calcium channel $\alpha 2\delta$ ligand, because such therapy is designed to reduce side effects of the calcium channel $\alpha 2\delta$ ligand *per se*, there are at present the cases where an analgesic effect is not sufficiently exhibited due to the reduced dosage of the calcium channel $\alpha 2\delta$ ligand, and the cases where new side effects occur due to the increased dosage of the drug used in combination therewith. For example, in the combined use of gabapentin and morphine, it has been reported that impairment in motor coordination occurs at a dosage sufficient to obtain the synergistic analgesic effect (Non-patent Document 13). Therefore, it has been thought that, even in the case of using any other drug in combination therewith, it is difficult to avoid the occurrence of side effects on the central nervous system while obtaining the synergistic analgesic effect.

[0008] Accordingly, an object of the present invention is to provide a therapeutic agent or a prophylactic agent for neuropathic pain, by which a synergistically- enhanced analgesic effect is obtained at a dosage at which a calcium channel $\alpha 2\delta$ ligand does not produce any side effects as well as which agent does not produce any new side effects on the central nervous system.

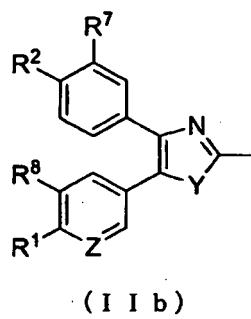
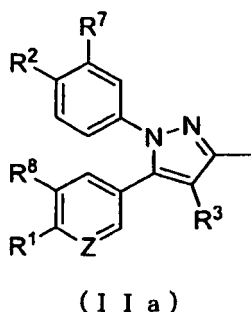
MEANS FOR SOLVING THE PROBLEMS

[0009] The present inventors intensively studied in order to solve the above-described problems and discovered that, when a calcium channel $\alpha 2\delta$ ligand is used in combination with a cyclohexane derivative which exhibits an excellent analgesic effect against neuropathic pain, the analgesic effect against neuropathic pain is synergistically enhanced without exacerbating side effects of the calcium channel $\alpha 2\delta$ ligand on the central nervous system.

[0010] That is, the present invention provides a therapeutic agent or prophylactic agent for neuropathic pain, said agent comprising as effective ingredients a cyclohexane derivative represented by Formula (I) below:



[wherein A is a substituent represented by Formula (IIa) or (IIb):



[0011] R^1 and R^2 are each independently a hydrogen atom, a chlorine atom, a C_1 - C_3 haloalkyl group, a C_1 - C_4 alkyl group or a C_1 - C_4 alkoxy group; R^3 is a hydrogen atom or a chlorine atom; R^4 is a fluorine atom, a hydroxymethyl group or a hydroxyl group; R^5 and R^6 are each independently a hydrogen atom, a fluorine atom, a C_1 - C_3 haloalkyl group, a carboxyl group, a methoxycarbonyl group, an ethoxycarbonyl group, a C_1 - C_4 alkoxy group, a hydroxyl group or a C_2 - C_5

alkylcarbonyloxy group, or optionally together form an oxo group; R⁷ and R⁸ are each independently a hydrogen atom or a fluorine atom; Y is an oxygen atom or a sulfur atom; and Z is a nitrogen atom or a methine group.]
or a pharmaceutically acceptable salt thereof, and a calcium channel $\alpha 2\delta$ ligand.

[0012] In the above-described cyclohexane derivative or a pharmaceutically acceptable salt thereof, it is preferred that R¹ and R² be each independently a trifluoromethyl group, a methyl group or a methoxy group; R³ be a hydrogen atom; R⁴ be a hydroxymethyl group or a hydroxyl group; and R⁵ and R⁶ be each independently a hydrogen atom, a fluorine atom, a trifluoromethyl group, a carboxyl group, a methoxy group, a hydroxyl group or an acetyloxy group (or R⁵ and R⁶ may optionally together form an oxo group).

[0013] The above-mentioned calcium channel $\alpha 2\delta$ ligand is preferably pregabalin or gabapentin, more preferably pregabalin.

EFFECTS OF THE INVENTION

[0014] The therapeutic agent or the prophylactic agent for neuropathic pain of the present invention can, while reducing the dose of the calcium channel $\alpha 2\delta$ ligand, synergistically enhance the analgesic effect which the calcium channel $\alpha 2\delta$ ligand has, and drastically reduce occurrence of the side effects on the central nervous system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 shows the effect of the combined use of Compound 3 and pregabalin in the mouse Seltzer model (changes over time at 1 hour, 2 hours and 3 hours after oral administration).

Fig. 2-A shows the effect of the combined use of Compound 3 and pregabalin in the mouse Seltzer model (at 1 hour after oral administration).

Fig. 2-B shows the effect of the combined use of Compound 3 and pregabalin in the mouse Seltzer model (at 2 hours after oral administration).

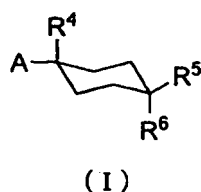
Fig. 3 shows the effect of the combined use of Compound 3 and pregabalin in the mouse wheel running test (from 0.5 to 1.5 hours after oral administration).

Fig. 4 shows the effect of the administration of pregabalin alone in the mouse Seltzer model (at 1 hour after oral administration).

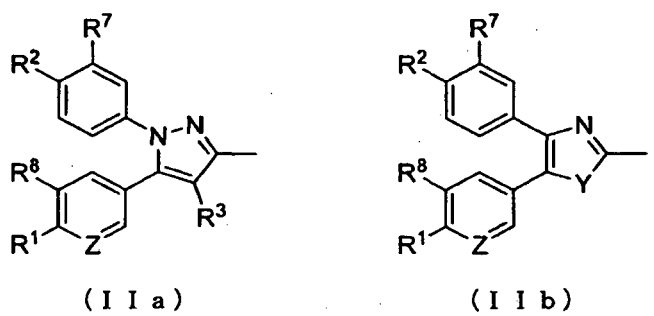
Fig. 5 shows the effect of the administration of pregabalin alone in the mouse wheel running test (from 0.5 to 1.5 hours after oral administration).

MODE FOR CARRYING OUT THE INVENTION

[0016] The therapeutic agent or the prophylactic agent for neuropathic pain of the present invention is characterized by comprising as effective ingredients a cyclohexane derivative represented by Formula (I) below or a pharmaceutically acceptable salt thereof, and a calcium channel $\alpha 2\delta$ ligand.



[wherein A is a substituent represented by Formula (IIa) or (IIb):



[0017] R¹ and R² are each independently a hydrogen atom, a chlorine atom, a C₁-C₃ haloalkyl group, a C₁-C₄ alkyl group or a C₁-C₄ alkoxy group; R³ is a hydrogen atom or a chlorine atom; R⁴ is a fluorine atom, a hydroxymethyl group or a hydroxyl group; R⁵ and R⁶ are each independently a hydrogen atom, a fluorine atom, a C₁-C₃ haloalkyl group, a carboxyl group, a methoxycarbonyl group, an ethoxycarbonyl group, a C₁-C₄ alkoxy group, a hydroxyl group or a C₂-C₅ alkylcarbonyloxy group, or R⁵ and R⁶ may optionally together form an oxo group; R⁷ and R⁸ are each independently a hydrogen atom or a fluorine atom; Y is an oxygen atom or a sulfur atom; and Z is a nitrogen atom or a methine group.]

[0018] The term "C₁-C₄ alkyl group" means a linear, branched or cyclic alkyl group having 1 to 4 carbon atoms, and examples thereof include a methyl group, an ethyl group, an *n*-propyl group, an isopropyl group, a cyclopropyl group, a cyclopropylmethyl group, an *n*-butyl group, a *sec*-butyl group and a *tert*-butyl group.

[0019] The term "C₁-C₄ alkoxy group" means a linear, branched or cyclic alkyl-oxy group having 1 to 4 carbon atoms, and examples thereof include a methoxy group, an ethoxy group, an *n*-propyloxy group, an isopropyloxy group, a cyclopropyloxy group, an *n*-butoxy group, a *sec*-butoxy group and a *tert*-butoxy group.

[0020] The term "C₁-C₃ haloalkyl group" means a linear alkyl group having 1 to 3 carbon atoms wherein a part or all of the hydrogen atoms on the group are replaced by a halogen atom(s) (the halogen atom means a fluorine atom, a chlorine atom, a bromine atom or an iodine atom), and examples thereof include a monochloromethyl group, a monofluoromethyl group, a difluoromethyl group, a trifluoromethyl group, a trichloromethyl group and a pentafluoroethyl group.

[0021] Examples of the "C₂-C₅ alkylcarbonyloxy group" include an acetyloxy group, an ethanoyloxy group, a propanoyloxy group, an isopropanoyloxy group, a butanoyloxy group, an isobutanoyloxy group and a pivaloyloxy group.

[0022] In Formula (I), A is preferably Formula (IIa); Y is preferably an oxygen atom; and Z is preferably a methine group.

[0023] R¹ is preferably a hydrogen atom, a chlorine atom, a trifluoromethyl group, a methyl group, an ethyl group, an *n*-propyl group, an isopropyl group, a methoxy group, an ethoxy group, an *n*-propyloxy group or an isopropyloxy group, more preferably a trifluoromethyl group, a methyl group or a methoxy group, and still more preferably a methyl group.

[0024] R² is preferably a hydrogen atom, a chlorine atom, a trifluoromethyl group, a methyl group, an ethyl group, an *n*-propyl group, an isopropyl group, a methoxy group, an ethoxy group, an *n*-propyloxy group or an isopropyloxy group, and more preferably a methoxy group.

[0025] R³ is preferably a hydrogen atom; and R⁴ is preferably a hydroxymethyl group or a hydroxyl group, and more preferably a hydroxyl group.

[0026] R⁵ is preferably a hydrogen atom, a fluorine atom, a trifluoromethyl group, a carboxyl group, a methoxy group, an ethoxy group, an *n*-propyloxy group, an isopropyloxy group, a hydroxyl group, an acetyloxy group, a propanoyloxy group, a butanoyloxy group or an isobutanoyloxy group, more preferably a hydrogen atom, a hydroxyl group or a carboxyl group, and still more preferably a hydroxyl group.

[0027] R⁶ is preferably a hydrogen atom, a fluorine atom, a trifluoromethyl group, a carboxyl group, a methoxy group, an ethoxy group, an *n*-propyloxy group, an isopropyloxy group, a hydroxyl group, an acetyloxy group, a propanoyloxy group, a butanoyloxy group or an isobutanoyloxy group, more preferably a hydrogen atom or a hydroxyl group, and still more preferably a hydrogen atom. R⁵ and R⁶ may optionally together form an oxo group.

[0028] R⁷ and R⁸ are each preferably a hydrogen atom.

[0029] Among cyclohexane derivatives represented by Formula (I) or pharmaceutically acceptable salts thereof (hereinafter referred to as Compound (I)), preferred specific examples are shown in Table 1, but the present invention is not limited by these.

[Table 1-1]

Compound	Structural Formula	Compound	Structural Formula
1		2	
3		4	
5		6	
7		8	
9		10	
11		12	
13		14	
15		16	

[Table 1-2]

Compound	Structural Formula	Compound	Structural Formula
17		18	

(continued)

Compound	Structural Formula	Compound	Structural Formula
19		20	
21		22	
23		24	
25		26	
27		28	
29		30	
31		32	

[Table 1-3]

Compound	Structural Formula	Compound	Structural Formula
33		34	
35		36	

(continued)

Compound	Structural Formula	Compound	Structural Formula
37		38	
39		40	
41		42	
43		44	
45		46	
47		48	

[Table 1-4]

Compound	Structural Formula	Compound	Structural Formula
49		50	
51		52	

(continued)

Compound	Structural Formula	Compound	Structural Formula
53		54	
55		56	
57		58	

[Table 1-5]

Compound	Structural Formula	Compound	Structural Formula
59		60	
61		62	
63		64	
65		66	
67		68	

(continued)

Compound	Structural Formula	Compound	Structural Formula
69		70	

[0030] Compound (I) includes all the enantiomers and mixtures thereof in cases where Compound (I) has an asymmetric carbon(s).

[0031] Compound (I) includes all the stereoisomers and mixtures thereof in cases where Compound (I) has a stereoisomer(s).

[0032] Examples of the calcium channel $\alpha_2\delta$ ligand to be used in combination with Compound (I) in the present invention include pregabalin (S-(+)-4-amino-3-(2-methylpropyl) butanoic acid or (S)-3-(aminomethyl)-5-(methylhexanoic acid)) and gabapentin (1-(aminomethyl)-cyclohexanecarboxylic acid or 2-[1-(aminomethyl) cyclohexane] acetic acid), and pharmaceutically acceptable salts thereof. Pregabalin or gabapentin is preferred, and pregabalin is more preferred.

[0033] Examples of the "pharmaceutically acceptable salt" include inorganic acid salts such as hydrochloric acid salt, sulfuric acid salt, phosphoric acid salt and hydrobromic acid salt; organic acid salts such as oxalic acid salt, malonic acid salt, citric acid salt, fumaric acid salt, lactic acid salt, malic acid salt, succinic acid salt, tartaric acid salt, acetic acid salt, trifluoroacetic acid salt, maleic acid salt, gluconic acid salt, benzoic acid salt, ascorbic acid salt, methanesulfonic acid salt, *p*-toluenesulfonic acid salt and cinnamic acid salt; inorganic base salts such as sodium salt, potassium salt, calcium salt, magnesium salt and ammonium salt; and organic base salts such as methylamine salt, diethylamine salt, trimethylamine salt, triethylamine salt, pyridinium salt, triethanolamine salt, ethylenediamine salt and guanidine salt. Further, Compound (I) may form a hydrate or a solvate, and crystalline polymorphs are also included therein.

[0034] Compound (I) may be synthesized, for example, according to a method as described in a published document (WO 10/050577).

[0035] The calcium channel $\alpha_2\delta$ ligand may be synthesized, for example, according to a method as described in a published document (JP 51-88940 A, JP 7-508288 A or JP 2004-536873 A).

[0036] A therapeutic agent or a prophylactic agent for neuropathic pain which comprises as effective ingredients Compound (I) and a calcium channel $\alpha_2\delta$ ligand also exhibits an excellent analgesic effect when administered to a mammal other than human. Examples of the mammal other than human include mouse, rat, hamster, rabbit, cat, dog, bovine, sheep and monkey.

[0037] Examples of the "neuropathic pain" include cancer pain, herpetic pain, postherpetic neuralgia, AIDS-related neuralgia, trigeminal neuralgia and diabetic neuropathic pain.

[0038] As for a mode of administration of a therapeutic agent or a prophylactic agent for neuropathic pain which comprises as effective ingredients Compound (I) and a calcium channel $\alpha_2\delta$ ligand, a mixture of both ingredients, i.e., a combination drug of both may be administered orally or parenterally as it is or after further combining it with a carrier which is acceptable as a pharmaceutical. Alternatively, Compound (I) and a calcium channel $\alpha_2\delta$ ligand may be individually prepared as single drugs, not as a combination drug, and then these may be administered at the same time as they are or after further combining each of them with a carrier which is acceptable as a pharmaceutical. Furthermore, the individual single drugs may also be administered such that either one of the single drugs is administered after the other at an appropriate interval. In these cases, the dosage forms and the administration routes of the individual single drugs do not need to be same, and may be different from each other. The "appropriate interval" as mentioned above may be confirmed clinically or by animal experiments.

[0039] Examples of the dosage form in cases where Compound (I) and a calcium channel $\alpha_2\delta$ ligand are orally administered as individual single drugs or as a combination drug include tablets (including sugar coated tablets and film coated tablets), pills, granules, powders, capsules (including soft capsules and microcapsules), syrups, emulsions and suspensions; and examples of the dosage form in cases where they are parenterally administered include injection solutions, impregnating agents, drops and suppositories. Furthermore, it is also effective to combine the effective ingredient(s) with an appropriate base (for example, a polymer of butyric acid, a polymer of glycolic acid, a copolymer of butyric acid-glycolic acid, a mixture of a polymer of butyric acid and a polymer of glycolic acid, a polyglycerol fatty acid ester or the like) to form a sustained release formulation(s).

[0040] Preparation of single drugs or a combination drug of Compound (I) and a calcium channel $\alpha_2\delta$ ligand in the above-mentioned dosage form may be carried out according to a known production method which is commonly used in the field of formulation of pharmaceuticals. In this case, the drugs may be produced such that an excipient, a binder, a lubricant, a disintegrator, a sweetener, a surfactant, a suspending agent, an emulsifier and/or the like which is(are)

commonly used in the field of formulation of pharmaceuticals is(are) contained therein as required.

[0041] Single drugs or a combination drug of Compound (I) and a calcium channel $\alpha 2\delta$ ligand may be prepared in the form of tablets such that an excipient, a binder, a disintegrator, a lubricant and/or the like is(are) contained therein; or in the form of pills or granules such that an excipient, a binder, a disintegrator and/or the like is(are) contained therein. In addition, the single drugs or the combination drug may be prepared in the form of powders or capsules such that an excipient and/or the like is contained therein; in the form of syrups such that a sweetener and/or the like is contained therein; or in the form of emulsions or suspensions such that a surfactant, a suspending agent, an emulsifier and/or the like is(are) contained therein.

[0042] Examples of the above-mentioned excipient include lactose, glucose, starch, sucrose, microcrystalline cellulose, powdered glycyrrhiza, mannitol, sodium hydrogen carbonate, calcium phosphate and calcium sulfate.

[0043] Examples of the above-mentioned binder include a starch paste solution, a gum arabic solution, a gelatin solution, a tragacanth solution, a carboxymethylcellulose solution, a sodium alginate solution and glycerin.

[0044] Examples of the above-mentioned disintegrator include starch and calcium carbonate.

[0045] Examples of the above-mentioned lubricant include magnesium stearate, stearic acid, calcium stearate and purified talc.

[0046] Examples of the above-mentioned sweetener include glucose, fructose, invert sugar, sorbitol, xylitol, glycerin and simple syrup.

[0047] Examples of the above-mentioned surfactant include sodium lauryl sulfate, polysorbate 80, sorbitan monofatty acid ester and polyoxyl 40 stearate.

[0048] Examples of the above-mentioned suspending agent include gum arabic, sodium alginate, sodium carboxymethylcellulose, methylcellulose and bentonite.

[0049] Examples of the above-mentioned emulsifier include gum arabic, tragacanth, gelatin and polysorbate 80.

[0050] In addition, in the preparation of single drugs or a combination drug of Compound (I) and a calcium channel $\alpha 2\delta$ ligand in the above-mentioned dosage form, a colorant, a preservative, an aromatic, a corrigent, a stabilizer, a thickener and/or the like which is(are) commonly used in the field of formulation of pharmaceuticals may be added therein.

[0051] The daily dose of the formulation which comprises a calcium channel $\alpha 2\delta$ ligand varies depending on the conditions and the body weight of the patient, the type of the inhibitor, the administration route and/or the like. For example, in cases where gabapentin is orally administered, it is preferred that administration be carried out at an amount of 10 to 3600 mg per adult (body weight: about 60 kg), once or up to three times dividedly; and in cases where pregabalin is orally administered, it is preferred that administration be carried out at an amount of 5 to 600 mg per adult (body weight: about 60 kg), once or up to three times dividedly. With regard to the daily dose of the formulation which comprises Compound (I), for example, in cases where the formulation is orally administered, it is preferred that administration be carried out at an amount of 1 to 1000 mg per adult (body weight: about 60 kg), once or up to three times dividedly; and, in cases where the formulation is parenterally administered, it is preferred that, if the formulation is injection solution, administration be carried out at an amount of 0.01 to 100 mg per 1 kg of body weight by intravenous injection.

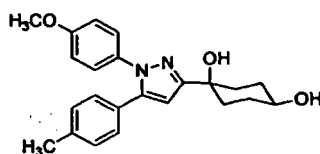
EXAMPLES

[0052] The present invention will now be described more concretely by way of an example thereof. However, the present invention is not restricted to the example below.

(Example 1) Combined Effect of Compound (I) and Calcium Channel $\alpha 2\delta$ Ligand in Mouse Neuropathic Pain Model:

[0053] For the evaluation, 7 to 8 male ICR mice of 5 weeks old were used for one experimental group. Mouse models of neuropathic pain were prepared according to Seltzer's method (Seltzer et al., Pain, 1990, vol. 43, p.205; Malmberg et al., Pain, 1998, vol. 76, p.215). That is, the sciatic nerve at the femoral region of the right hindlimb of each mouse was exposed under anesthesia, and the sciatic nerve was triply ligated tightly with silk suture of 8-0 (NATSUME SEI-SAKUSHO) under microscope so that only half thickness of the nerve was trapped in the ligature.

[0054] As a test compound, 1-(1-(4-methoxyphenyl)-5-(p-tolyl)-1H-pyrazol-3-yl)cyclohexan-*cis*-1,4-diol (hereinafter referred to as Compound 3), which was represented by the following formula and included in Compound (I), was selected.



As a calcium channel $\alpha 2\delta$ ligand, pregabalin was selected.

[0055] The mouse models of neuropathic pain were splitted into 4 groups; a group treated with vehicle (Vehicle in Fig. 1 and Fig. 2), a group treated with 3 mg/kg pregabalin alone (Pregabalin in Fig. 1 and Fig. 2), a group treated with 0.3 mg/kg Compound 3 alone (Compound 3 in Fig. 1 and Fig. 2), and a group concomitantly treated with 3 mg/kg pregabalin and 0.3 mg/kg Compound 3 (Pregabalin + Compound 3 in Fig. 1 and Fig. 2).

[0056] Seven days after the above-described sciatic nerve ligation, using 0.5% methylcellulose as a vehicle, mice of each group received administration of vehicle, administration of a suspension of pregabalin (3 mg/kg) alone, administration of a suspension of Compound 3 (0.3 mg/kg) alone, or administration (combined administration) of a mixed suspension of pregabalin and Compound 3 (3 mg/kg and 0.3 mg/kg, respectively).

[0057] Evaluation of neuropathic pain (hereinafter "von Frey test") was carried out as follows. Mouse models of neuropathic pain were conditioned for at least 1 hour in an acryl cage for measurement (NATSUME SEISAKUSHO) placed on a wire net. Thereafter, using a filament (North Coast Medical. Inc.) which exerted a pressure of 0.16 g, the mice were subjected to mechanical tactile stimulus by applying the filament to the plantar surface of both hindpaws 3 times, each for 3 seconds, with an interval of 3 seconds. The withdrawal response observed during each mechanical tactile stimulus was scored (0, no response; 1, showed slow and/or slight withdrawal response in response to the stimulation; 2, showed quick withdrawal response without flinching (shaking paws quickly and continuously) nor licking (licking paws) in response to the stimulation; 3, showed quick withdrawal response with flinching and/or licking), and the sum of the scores obtained in the triplicate trials were used as a total score.

[0058] Seven days after sciatic nerve ligation, von Frey test was carried out before administration of the test compound, 1 hour after administration, 2 hours after administration, and 3 hours after administration. Change in the total scores from before to after administration of the test compound (hereinafter " Δ vF test score") was calculated by subtracting the total score obtained at each time point after administration of the test compound from the total score obtained before administration of the test compound, which was used as an indicator of analgesic effect.

[0059] A theoretical total value, which was the theoretical Δ vF test score calculated on the assumption that combined use of Compound 3 and pregabalin exhibited no more than an additive analgesic effect, was calculated based on the Δ vF test scores obtained when Compound 3 or pregabalin was administered alone. That is, individual Δ vF test scores of the mice in the group treated with pregabalin alone and the mice in the group treated with Compound 3 alone were sorted in ascending order, respectively, and Δ vF test scores of the two groups at the same rank were added, thereby obtaining a theoretical total value.

[0060] Results of the evaluation are shown in Fig. 1, Fig. 2-A and Fig. 2-B. In the figures, the vertical axis shows the Δ vF test score of the von Frey test, and a higher score indicates a stronger analgesic effect. The horizontal axis of Fig. 1 shows time after administration of the test compound, and that of Fig. 2 shows how each group was treated.

[0061] Statistical comparison between the group treated with vehicle and the groups treated with drugs at each time point was carried out using Dunnett's test since interactions between group and time were found to be significant by two-way ANOVA (with a level of significance of less than 5%). The symbol # in the figures indicates a significant difference (###p<0.001) from the group treated with vehicle. Statistical comparison between the group concomitantly treated with 3 mg/kg pregabalin and 0.3 mg/kg Compound 3 (Pregabalin + Compound 3 in Fig. 2) and the theoretical total value was carried out using Student's t-test since variances were found to be equal by F-test (with a level of significance of less than 5%). The symbol * in the figures indicates a significant difference (*p<0.05, **p<0.01) from the theoretical total value.

[0062] In the group treated with 3 mg/kg pregabalin alone (Pregabalin in Fig. 1 and Fig. 2), an analgesic effect was not observed at any time points of 1 hour, 2 hours and 3 hours after administration. Also in the group treated with 0.3 mg/kg Compound 3 alone (Compound 3 in Fig. 1 and Fig. 2), an analgesic effect was not observed at any time points of 1 hour, 2 hours and 3 hours after administration.

[0063] On the other hand, in the concomitant treatment group (Pregabalin + Compound 3 in Fig. 1 and Fig. 2), a strong analgesic effect was observed 1 hour and 2 hours after administration with a statistical significance when compared to the vehicle treatment group (Vehicle in Fig. 1 and Fig. 2). Furthermore, a statistically significant difference was found between the theoretical total value (Theoretical Total Value in Fig. 2) and the concomitant treatment group (Pregabalin + Compound 3 in Fig. 2) at time points of both 1 hour and 2 hours after administration. These results clearly indicate that Compound (I) and a calcium channel $\alpha 2\delta$ ligand synergistically enhance their analgesic effects each other when used in combination.

(Example 2) Combined Effect of Compound (I) and Calcium Channel $\alpha 2\delta$ Ligand in Mouse Wheel Running Test:

[0064] For the evaluation, 8 male ddY mice of 5 weeks old were used for one experimental group. The test compound, grouping of mice, vehicle used and administration method were the same as in Example 1.

[0065] Mice were placed in a running wheel apparatus (NATSUME SEISAKUSHO) 0.5 hour after administration of the test compound, and the number of revolutions of the running wheel was counted for a period of 1 hour immediately thereafter to evaluate a motor inhibitory effect.

[0066] Results of the evaluation are shown in Fig. 3. The vertical axis shows the number of revolutions in the wheel

running test. A higher value indicates that mice are more physically-active. The horizontal axis shows how each group was treated.

[0067] Statistical comparison between the vehicle treatment group (Vehicle in Fig. 3) and the drug treatment groups was carried out using Student's t-test since variances were found to be equal by F-test (with a level of significance of less than 5%).

[0068] No statistically-significant motor inhibitory effect was found in the group treated with 3 mg/kg pregabalin alone (Pregabalin in Fig. 3) and in the group treated with 0.3 mg/kg Compound 3 alone (Compound 3 in Fig. 3). Further, no statistically-significant motor inhibitory effect was found also in the group concomitantly treated with 3 mg/kg pregabalin and 0.3 mg/kg Compound 3 (Pregabalin + Compound 3 in Fig. 3). These results clearly indicate that the central nervous system does not adversely affected by combined use of Compound (I) and a calcium channel $\alpha 2\delta$ ligand each in a dose not adversely affecting the central nervous system.

(Comparative Example 1) Effect of Calcium Channel $\alpha 2\delta$ Ligand in Mouse Models of Neuropathic Pain:

[0069] In the same manner as in Example 1, effects of oral administration of 1, 3, 10 and 30 mg/kg pregabalin alone were evaluated 1 hour after administration in mouse models of neuropathic pain.

[0070] Results of evaluation are shown in Fig. 4. Statistical comparison between the group treated with vehicle (Vehicle in Fig. 4) and the groups treated with pregabalin (Pregabalin 1 mg/kg, Pregabalin 3 mg/kg, Pregabalin 10 mg/kg and Pregabalin 30 mg/kg in Fig. 4) was carried out using Williams test (one-way) since variances were found to be equal by Bartlett test (with a level of significance of less than 5%). The symbol * in the figure indicates a significant difference (* $p < 0.025$) from the group treated with vehicle.

[0071] No analgesic effect was observed when 1 or 3 mg/kg of pregabalin was orally administered alone. On the other hand, a statistically-significant analgesic effect was observed when 10 or 30 mg/kg of pregabalin was orally administered alone. In addition, it was thought that the analgesic effect of 30 mg/kg pregabalin was about the same level as that of the combined administration of 3 mg/kg pregabalin and 0.3 mg/kg Compound 3.

(Comparative Example 2) Effect of Calcium Channel $\alpha 2\delta$ Ligand in Mouse Wheel Running Test:

[0072] In the same manner as in Example 2, motor inhibitory effects of oral administration of 30 and 100 mg/kg pregabalin were evaluated.

[0073] Results of evaluation are shown in Fig. 5. Statistical comparison between the group treated with vehicle (Vehicle in Fig. 5) and the groups treated with 30 and 100 mg/kg pregabalin (Pregabalin 30 mg/kg and Pregabalin 100 mg/kg in Fig. 5, respectively) was carried out using Williams test (one-way) since variances were found to be equal by Bartlett test (with a level of significance of less than 5%). The symbol * in the figure indicates a significant difference (* $p < 0.025$) from the group treated with vehicle.

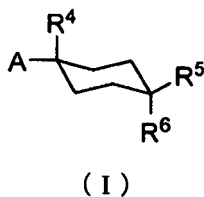
[0074] Oral administration of 30 or 100 mg/kg pregabalin alone statistically significantly reduced the number of revolutions, thereby confirming a motor inhibitory effect.

INDUSTRIAL APPLICABILITY

[0075] The present invention is an agent comprising as effective ingredients Compound (I) and a calcium channel $\alpha 2\delta$ ligand, and can be used as a pharmaceutical, especially as a therapeutic agent or a prophylactic agent for neuropathic pain.

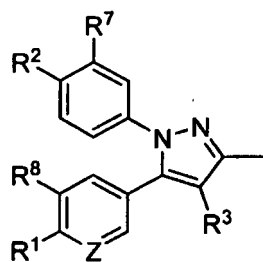
Claims

1. An agent for use in the treatment and prophylaxis of neuropathic pain, said agent comprising as effective ingredients a cyclohexane derivative represented by Formula (I) below:

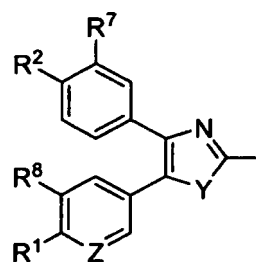


[wherein

A is a substituent represented by Formula (IIa) or (IIb):



(IIa)



(IIb)

;

R¹ and R² are each independently a hydrogen atom, a chlorine atom, a C₁-C₃ haloalkyl group, a C₁-C₄ alkyl group or a C₁-C₄ alkoxy group;

R³ is a hydrogen atom or a chlorine atom; R⁴ is a fluorine atom, a hydroxymethyl group or a hydroxyl group;

R⁵ and R⁶ are each independently a hydrogen atom, a fluorine atom, a C₁-C₃ haloalkyl group, a carboxyl group, a methoxycarbonyl group, an ethoxycarbonyl group, a C₁-C₄ alkoxy group, a hydroxyl group or a C₂-C₅ alkyl-carbonyloxy group, or optionally together form an oxo group;

R⁷ and R⁸ are each independently a hydrogen atom or a fluorine atom;

Y is an oxygen atom or a sulfur atom;

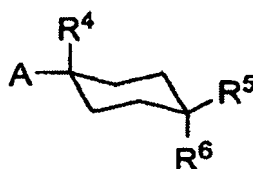
Z is a nitrogen atom or a methine group.]

or a pharmaceutically acceptable salt thereof, and a calcium channel $\alpha_2\delta$ ligand.

2. The agent for use according to claim 1, wherein R¹ and R² are each independently a trifluoromethyl group, a methyl group or a methoxy group.
3. The agent for use according to claim 1 or 2, wherein R³ is a hydrogen atom.
4. The agent for use according to any one of claims 1 to 3, wherein R⁴ is a hydroxymethyl group or a hydroxyl group.
5. The agent for use according to any one of claims 1 to 4, wherein R⁵ and R⁶ are each independently a hydrogen atom, a fluorine atom, a trifluoromethyl group, a carboxyl group, a methoxy group, a hydroxyl group or an acetyloxy group, or optionally together form an oxo group.
6. The agent for use according to any one of claims 1 to 5, wherein said calcium channel $\alpha_2\delta$ ligand is pregabalin or gabapentin.

Patentansprüche

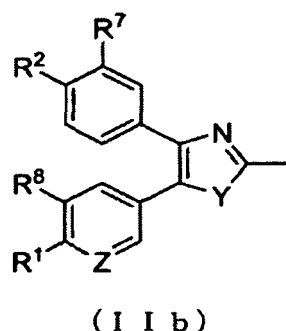
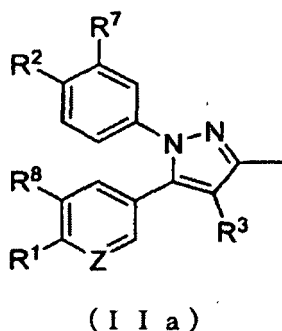
1. Wirkstoff zur Verwendung in der Behandlung und Prophylaxe von neuropathischem Schmerz, wobei der Wirkstoff als wirksamen Inhaltsstoff ein Cyclohexanderivat umfasst, welches durch die Formel (I) unten dargestellt wird:



(I)

[wobei

A ein Substituent ist, der durch Formel (IIa) oder (IIb) dargestellt wird:



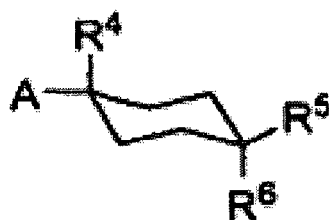
R¹ und R² jeweils unabhängig ein Wasserstoffatom, ein Chloratom, eine C₁ - C₃ Haloalkylgruppe, eine C₁ - C₄ Alkylgruppe oder eine C₁ - C₄ Alkoxygruppe sind;
 R³ ein Wasserstoffatom oder ein Chloratom ist; R⁴ ein Fluoratom, eine Hydroxymethylgruppe oder eine Hydroxylgruppe ist;
 R⁵ und R⁶ jeweils unabhängig ein Wasserstoffatom, ein Fluoratom, eine C₁ - C₃ Haloalkylgruppe, eine Carboxylgruppe, eine Methoxycarbonylgruppe, eine Ethoxycarbonylgruppe, eine C₁ - C₄ Alkoxygruppe, eine Hydroxylgruppe oder eine C₂ - C₅ Alkylcarbonyloxygruppe sind oder optional zusammen eine Oxogruppe bilden;
 R⁷ und R⁸ jeweils unabhängig ein Wasserstoffatom oder ein Fluoratom sind;
 Y ein Sauerstoffatom oder ein Schwefelatom ist;
 Z ein Stickstoffatom oder eine Methingruppe ist.]

oder ein pharmazeutisch akzeptables Salz davon und ein Kalziumkanal $\alpha 2\delta$ Ligand.

2. Wirkstoff zur Verwendung gemäß Anspruch 1, wobei R¹ und R² jeweils unabhängig eine Trifluormethylgruppe, eine Methylgruppe oder eine Methoxygruppe sind.
3. Wirkstoff zur Verwendung gemäß Anspruch 1 oder 2, wobei R³ ein Wasserstoffatom ist.
4. Wirkstoff zur Verwendung gemäß Anspruch 1 bis 3, wobei R⁴ eine Hydroxymethylgruppe oder eine Hydroxylgruppe ist.
5. Wirkstoff zur Verwendung gemäß einem der Ansprüche 1 bis 4, wobei R⁵ und R⁶ jeweils unabhängig ein Wasserstoffatom, ein Fluoratom, eine Trifluormethylgruppe, eine Carboxylgruppe, eine Methoxygruppe, eine Hydroxylgruppe oder eine Acetyloxygruppe sind oder optional zusammen eine Oxogruppe bilden.
6. Wirkstoff zur Verwendung gemäß einem der Ansprüche 1 bis 5, wobei der Kalziumkanal $\alpha 2\delta$ Ligand Pregabalin oder Gabapentin ist.

Revendications

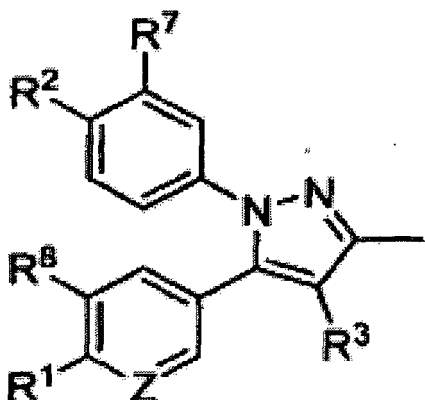
1. Agent destiné à être utilisé dans le traitement et la prophylaxie d'une douleur neuropathique, ledit agent comprenant en tant qu'ingrédients efficaces un dérivé de cyclohexane représenté par la formule (I) ci-dessous :



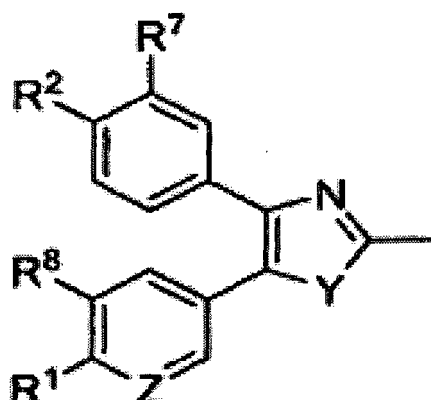
(I)

[dans laquelle

A est un substituant représenté par la formule (IIa) ou (IIb) :



(I I a)



(I I b)

R¹ et R² sont chacun indépendamment un atome d'hydrogène, un atome de chlore, un groupe halogénoalkyle en C₁ à C₃, un groupe alkyle en C₁ à C₄ ou un groupe alcoxy en C₁ à C₄ ;

R³ est un atome d'hydrogène ou un atome de chlore ; R⁴ est un atome de fluor, un groupe hydroxyméthyle ou un groupe hydroxyle ;

R⁵ et R⁶ sont chacun indépendamment un atome d'hydrogène, un atome de fluor, un groupe halogénoalkyle en C₁ à C₃, un groupe carboxyle, un groupe méthoxycarbonyl, un groupe éthoxycarbonyl, un groupe alcoxy en C₁ à C₄, un groupe hydroxyle ou un groupe (alkyle en C₁ à C₄)carbonyloxy ou forment ensemble facultativement un groupe oxo ;

R⁷ et R⁸ sont chacun indépendamment un atome d'hydrogène ou un atome de fluor ;

Y est un atome d'oxygène ou un atome de soufre ;

Z est un atome d'azote ou un groupe méthine],

ou un sel pharmaceutiquement acceptable de celui-ci, et un ligand $\alpha\delta$ des canaux calciques.

2. Agent destiné à être utilisé selon la revendication 1, dans lequel R¹ et R² sont chacun indépendamment un groupe trifluorométhyle, un groupe méthyle ou un groupe méthoxy.
3. Agent destiné à être utilisé selon les revendications 1 ou 2, dans lequel R³ est un atome d'hydrogène.
4. Agent destiné à être utilisé selon l'une quelconque des revendications 1 à 3, dans lequel R⁴ est un groupe hydroxyméthyle ou un groupe hydroxyle.
5. Agent destiné à être utilisé selon l'une quelconque des revendications 1 à 4, dans lequel R⁵ et R⁶ sont chacun indépendamment un atome d'hydrogène, un atome de fluor, un groupe trifluorométhyle, un groupe carboxyle, un

groupe méthoxy, un groupe hydroxyle ou un groupe acétyloxy, ou forment ensemble facultativement un groupe oxo.

6. Agent destiné à être utilisé selon l'une quelconque des revendications 1 à 5, dans lequel ledit ligand $\alpha 2\delta$ des canaux calciques est la prégabaline ou la gabapentine.

5

10

15

20

25

30

35

40

45

50

55

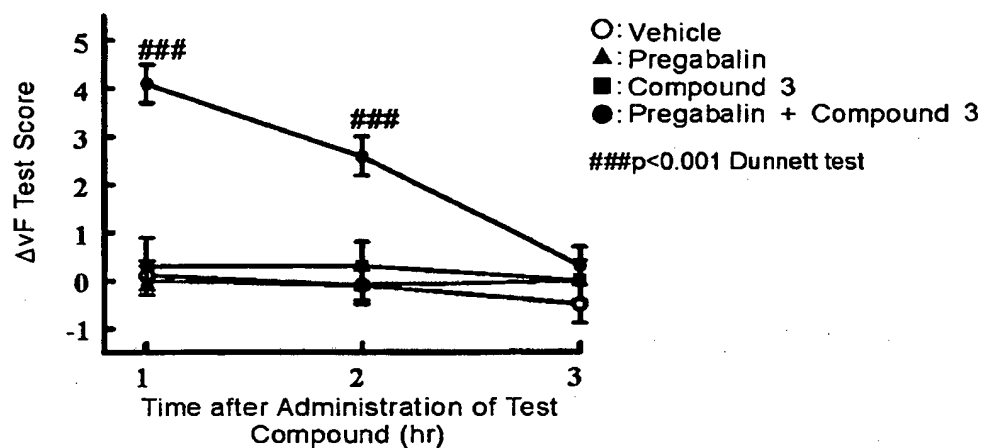


Fig.1

1 Hour after Administration of Test Compound

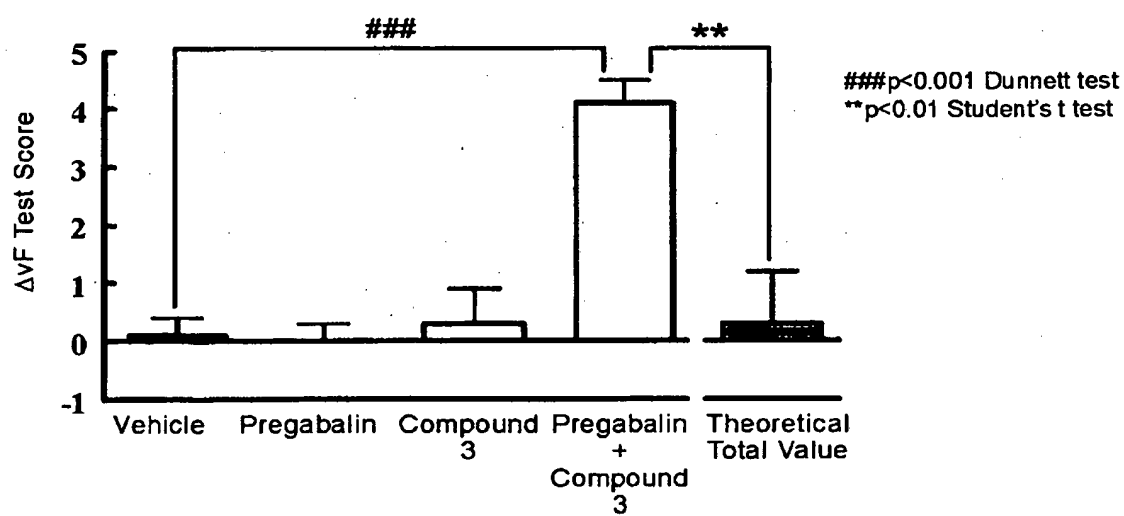


Fig.2-A

2 Hours after Administration of Test Compound

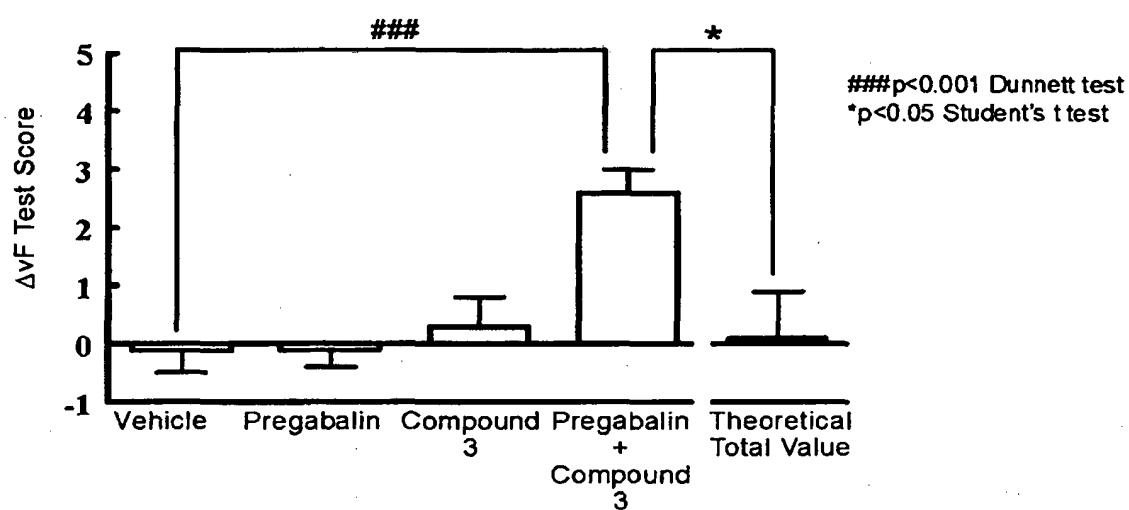


Fig.2-B

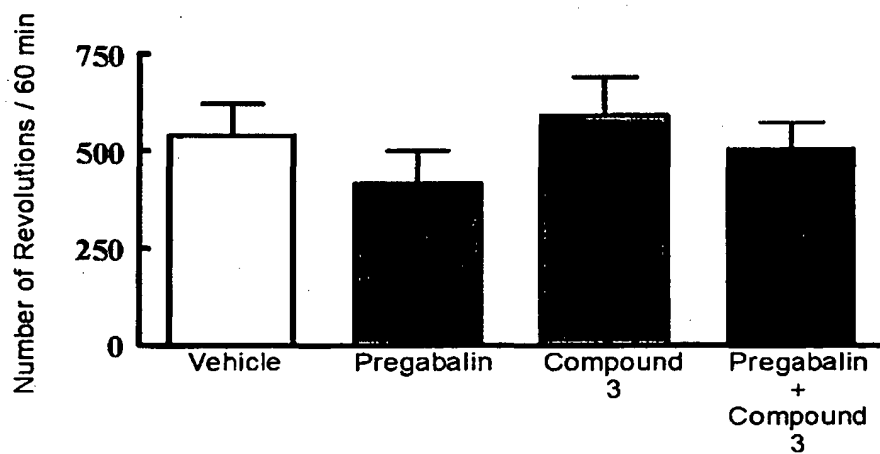


Fig.3

1 Hour after Administration of Test Compound

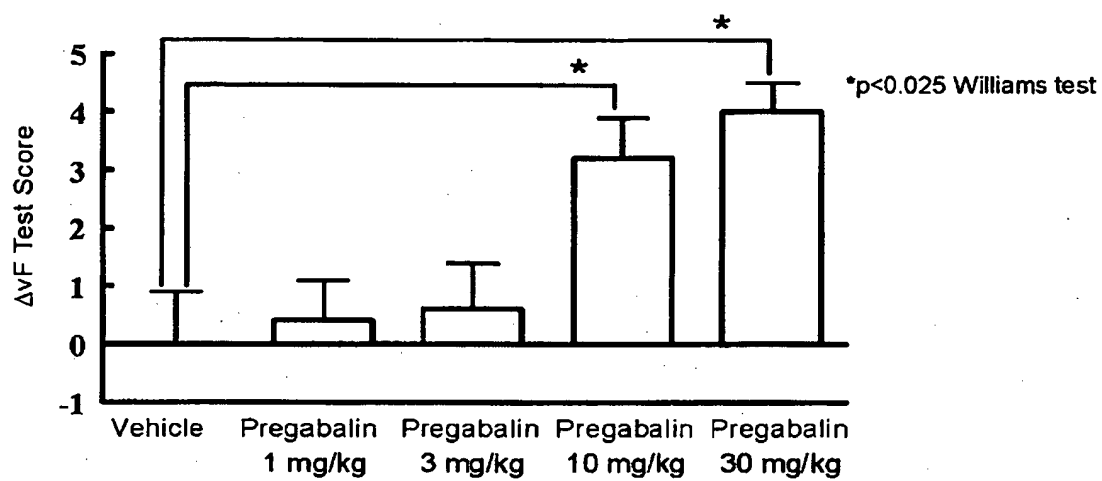


Fig.4

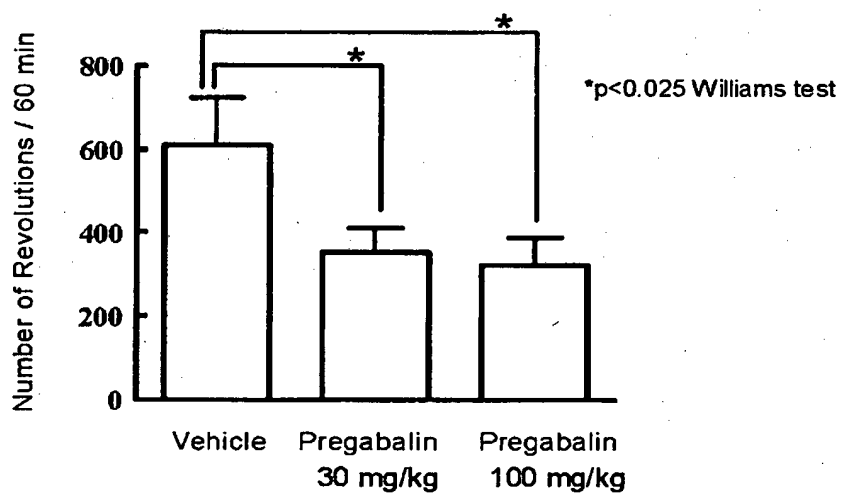


Fig.5

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 04016259 A [0005]
- WO 10025931 A [0005]
- WO 09021058 A [0005]
- WO 08079727 A [0005]
- WO 08079720 A [0005]
- WO 07090661 A [0005]
- WO 05102390 A [0005]
- WO 05025675 A [0005]
- WO 01024792 A [0005]
- WO 01013904 A [0005]
- WO 10050577 A [0005] [0034]
- JP 51088940 A [0035]
- JP 7508288 A [0035]
- JP 2004536873 A [0035]

Non-patent literature cited in the description

- **DOOLEY et al.** *Trends Pharmacol Sci*, 2007, vol. 28, 75 [0006]
- **ZACCARA et al.** *Seizure*, 2008, vol. 17, 405 [0006]
- **HAMA et al.** *Neuropharmacology*, 2010, vol. 58, 758 [0006]
- **CURROS-CRIADO et al.** *Br J Pharmacol*, 2009, vol. 158, 601 [0006]
- **HANNA et al.** *Eur J Pain*, 2008, vol. 12, 804 [0006]
- **MIXCOATL-ZECUATL et al.** *Methods Find Exp Clin Pharmacol*, 2008, vol. 30, 431 [0006]
- **HAYASHIDA et al.** *Eur J Pharmacol*, 2008, vol. 598, 21 [0006]
- **TOMIC et al.** *Eur J Pharmacol*, 2010, vol. 628, 75 [0006]
- **PARK et al.** *J Korean Med Sci*, 2008, vol. 23, 678 [0006]
- **IMAI et al.** *Eur J Pharmacol*, 2008, vol. 588, 244 [0006]
- **CODD et al.** *Pain*, 2008, vol. 134, 254 [0006]
- **HAYASHIDA et al.** *Anesthesiology*, 2007, vol. 106, 1213 [0006]
- **DE LA O-ARCINIEGA et al.** *Pharmacol Biochem Behav*, 2009, vol. 92, 457 [0006]
- **SELTZER et al.** *Pain*, 1990, vol. 43, 205 [0053]
- **MALMBERG et al.** *Pain*, 1998, vol. 76, 215 [0053]